GOVERNING THE MODERN, NEOLIBERAL CHILD THROUGH ICT RESEARCH IN MATHEMATICS EDUCATION

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In this journal, Walshaw (2014) recently discussed the appropriation of Michel Foucault's work with the "interest of reconfiguring learning as a political and moral project" (p. 2). She argues that concepts such as governmentality and technologies of the self provide tools to think of mathematics learning as a "project of freedom, of going beyond the 'limits' that descend from the learner's own particular historical situation and circumstances" (p. 5). In a subsequent comment, Appelbaum (2014) questions Walshaw's perspective for not considering how a Foucauldian analysis, without "a critical perspective on the self-based regimes of truth" (p. 17), risks reinforcing "those regimes of truth, rather than working for social justice and social change" (p. 17). Both Walshaw's and Appelbaum's work is at the forefront of research on the political in mathematics education. Their proposal, however, is circumscribed within the realm of learning, the learner and the promise of emancipation through education. Although important, it is not the only possibility for researching the political in mathematics education.

Our overall intention is to approach mathematics education as political without asking questions about learning and emancipation. Rather we examine, as Walshaw (2014) herself suggests, the practices that "constitute, define, organize [and] instrumentalize" (p. 4) ways of reasoning about the making of the learner of mathematics as a historical subject. More specifically, we examine how the expert knowledge of mathematics education research contributes to the making of the desired subjects of our time with and through the use of ICTs: flexible, employable, competitive consumers who can also be entrepreneurs of themselves (European Commission, 2012). We take Foucault's concept of *governmentality* as a key theoretical tool and analyze a corpus of empirical data consisting of the papers in the section "Technology in the mathematics curriculum" in the *Third International Mathematics Education Research Handbook* (Clements, Bishop, Keitel, Kilpatrick & Leung, 2013, pp. 517-790). Our analysis casts a critical light on the optimism in this work for the adoption of ICT to advance mathematical learning and produce digital capable citizens.

We braid together two main points. First, while many existing studies analyze the political of mathematics education through a focus on educational practices, we set our gaze on research itself. The discourse of mathematics education research, produced by the experts of this field of knowledge, impacts the mathematics education community as a whole, because it contributes to organizing and performing the subjectivation of people. A cultural, historical perspective of education based on the work of Foucault, suggests that since the beginning of the twentieth-century, when educational sciences were being formed as recognized fields of scholarship, their role in providing expert-knowledge for the engineering of humans and society has been unquestionable (*e.g.,* Popkewitz, 2008b). Thus the connection between research and school practice is not to be found in how descriptions and explanations provided by research can become graspable knowledge and recommendations for teachers to implement, in order to to improve their practice and their students' learning. This connection is instead found in how research articulates the rationalities that govern educational practice, and how it frames the terms of what is desirable and how it can be achieved (Popkewitz & Brennan, 1998). It is in this contribution to the fabrication of educational subjects that the political in educational research is to be found. Following Foucault (1982), the central problem for the study of power in education is how human beings become subjects through the objectifying effects of scientific knowledge, through divisive practices, and through their conduct of their own conduct. What is scientifically said about us constrains the possibilities of our experience. It works on our subjectivity because it has effects on our ways of being: on who we (and society) think we are.

Second, our analysis uses Foucault's notion of governmentality to expand understandings of how mathematics education fabricates the desired child in contemporary societies. While existing studies in mathematics education have shown how educational practices and their discourses are aligned with neoliberal ideologies (*e.g.,* Mendick, Moreau & Epstein, 2009; Doğan & Haser, 2014), we show how the pedagogies devised by research are technologies that conduct the conduct of teachers and children alike. Research on ICT and the teaching and learning of mathematics addresses current developments in our increasingly technologized societies. From the point of view of governmentality, the artifacts of ICT can be understood as much more than the mediating tools for cognition and knowledge objectification that existing theories in the field would suggest (for example, the theory of instrumental genesis: see Artigue, 2002). These artifacts, when part of pedagogical practices, also have an effect on the self. Reasoning with the ideas of

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Daston and Gallison (2007), we argue that tools that are part of a practice of knowing generate effects both on the form of knowing and on the subject who knows. These effects arise because the knowing subject, as part of collective practices, has to train him/her self in a particular way in order to be able to think and understand the world effectively with new technologies. There is therefore an effect on how people understand and learn to conduct themselves to become part of a practice. Thus, it is not enough to conceptualize a technological device as a mediator of cognition; it is also, in Foucauldian terms, a technology of the self.

Analyzing with the concept of governmentality

The concept of governmentality is one of the central notions of Foucault's late work. It provides new ways of analyzing how power relations work. Lemke argues that the "analytics of governmentality explore the practices of government in their complex relations to the various ways in which 'truth' is produced in social, cultural and political spheres" (Lemke, 2002, p. 4). Governmentality thus provides a way of thinking about how power is effected through practices of government that generate forms of reasoning and related, taken-for-granted truths. Governmentality is "the regulation of conduct by the more or less rational application of appropriate technical means" (Hindess, 1996, p. 106). In particular, we are interested in how government technologies regulate conduct through generating the systems of reason in which forms of life and subjectivity are made possible, organized and constrained. The link between government and the constitution of desired subjects is one of the most salient points in Foucault's analytics of power. In the case of education, diverse government techniques institute a political rationality that fabricates the people of education. These people include not only the child, but also the teacher, the parents, the school leaders and many others—even researchers.

Foucault's concept of governmentality allows us to consider mathematics education as a discourse produced in different spheres of social life, through educational public policies, school curricula, textbooks, research publications, classroom practices, examinations and so on. Such spheres are not isolated but interact with one another in the production of the statements and related truths that shape that discourse. In this article, we focus on a specific sphere of its production: international research in mathematics education. Using the analytics of governmentality, we can assume that mathematics education research is part of a dispositive that conducts the conduct not only of researchers, but also of all the others who are part of the practices of mathematics education. The technologies devised by mathematics education research are more easily accepted, and thus more effective in conducting conduct, because of its social legitimization as expert, scientific knowledge. The technologies of mathematics education research subject the subjects involved to political rationalities that in different sites of social life, govern their conduct in particular ways. More concretely, the question we explore is: how does ICT research in mathematics education conduct the conduct of school subjects, in order to fabricate the desired rational, techno-scientific and entrepreneurial subjects of education?

To answer this question, we choose to look at the *Third International Mathematics Education Research Handbook* (Clements *et al.,* 2013). The handbook is based on the assumption that "mathematics education research has a vitally important role to play in improving mathematics curricula and the teaching and learning of mathematics" (p. v). The research presented in this international, collective effort "provides an invaluable, state-of-the-art compendium of the most recent, and promising, developments in the field" (p. v). We selected the section *Technology in the mathematics curriculum* (pp. 517-790). This section spans 273 pages and is composed of one introductory text (pp. 517-524) and eight chapters addressing various aspects of the use of different ICTs in the mathematics curriculum. The section as a whole acknowledges that:

> students of the modern technological era have the possibility of learning more exciting forms of mathematics more effectively than ever before [...] So in essence, modern technology is changing both the way we learn 'traditional' mathematics and, simultaneously, the nature of the mathematics that we learn [...] this section of the *Third International Handbook* covers the impact of technology on the school mathematics curriculum comprehensively and in some depth [...] technology is not merely something which can enhance the teaching, learning and assessment of standard mathematics. It has the potential to change the nature of the mathematics taught, learned and assessed." (pp. 518-522)

We deploy a Foucault-inspired discourse analysis (Arribas-Ayllon & Walkerdine, 2008) on this text. An important starting point is Foucault's position that the author is not the origin of the discourse (Deleuze, 1988, p. 64). This means that when analyzing texts, we do not evaluate the concrete people who wrote them. We are not interested in assigning value judgments about the authors' ideas or intentions, or in revealing the internal logic of the texts. We examine the statements in their exteriority, not in what might exist behind what is said. Therefore, in this article, we cite the pages of the handbook and not the authors who wrote the papers.

We looked in the text for statements on the desired subjects of mathematics education. In particular, in the whole of the text, we noticed enunciations about learners. We followed an abductive process, connecting existing educational and philosophical literature about subjectivity in Modernity and neoliberalism with particular enunciations in the texts that resonated with such ideas. From this process, there emerged two articulating rationalities. First, school mathematics seeks to insert in children the credo of Modernity, in which science and technology are the pillars of secure, absolute truths, progress, rational planning of the social order, and the standardization of knowledge and production (Sarup & Raja, 1996). Second, mathematics education contributes to the construction of subjectivities according to a neoliberal rationality. Neoliberalism, as an approach to social and economic policy resting on ideas such as economic growth, competition, and the rights of the individual (Lemke, 2001), transforms people into self-regulated, competitive entrepreneurs (Gadelha, 2009). We contend that adherence to the scientific-technological rationality of Modernity and to Neoliberal rationality are strongly present in the ways of understanding the learner who operates with ICTs. In the following section, we present the results of our analysis by showing how the enunciations in the Handbook are connected to these two articulating rationalities.

The desirable Modern child of ICT research

What characterizes the Modern self and how does mathematics education as a technology of government of others and of the self inscribe in children such characteristics to make them into the desired child? Poovey (1998) unfolds a study of the historical and cultural conditions through which quantitative representations of qualitative forms of knowledge increasingly appeared to be more solid and true. The almost "preinterpretive or even somehow noninterpretive" (p. xii) view of numbers became the solid ground on which systematic knowledge started to be built. That numbers came to epitomize Modern forms of knowing in constituting "facts" is associated with a historical transformation effecting forms of governing of the self. Epistemologically, this type of self was governed to adopt a belief in the universalism of human beings, in systematic knowledge of a theoretical nature, and in the subordination of particulars to "abstractions that could not be seen" (p. xxi), among others. From quantifications to political arithmetic, the increasing mathematization in expert knowledge for governing produced new forms of knowing and being. These scientific epistemological forms are privileged in Modernity.

Using the concept of governmentality, Popkewitz (2008a) analyzes the school curriculum and the technologies through which it fabricates the Modern child. This type of self embodies forms of reasoning that revolve around the belief of science-based human reason having a universal, emancipatory capacity for changing the world and people. Agency, progress and the planning of the future with and through science are elements of the Modern being with a "homeless mind" (p. 29), a type of "individuality that is both an object and a subject of reflection" and that places "individuals in a relation to transcendental categories that seem to have no particular historical location or author to establish a home" (p. 30). As we illustrate below, mathematics education is one of the technologies of government that most effectively can inscribe these norms of reason in the self. Mathematics education in the twenty-first century continues the unachieved task of bringing into life the promises of the Enlightenment and Modernity.

Enunciations in the Handbook allow us to see how current pedagogical practices in mathematics with technology bring these characteristics of the Modern self into children by fostering the capacity of constructing mathematical knowledge and, as a result, operating and acting with abstract and formalized forms of thinking. Starting from particular observations or from everyday experiences students are conducted to develop and appropriate quantitative, abstract and general knowledge:

> According to their use of measurements, students can construct mathematical meanings, formulate conjectures, check them or use them to construct a proof, in a continuous process from exploration to the final product of a formal proof. (p. 581)

> When students use measurements as a means of checking the validity of a perception: having the intuition on a property, but not being sure of it, they use measurements to validate the perception, by transforming a qualitative relationship into a quantitative one, and remain in the spatio-graphical field. (p. 583)

The move from the particularity of measurements to the generation of formal proofs, facilitated by ICT, becomes an effective way of inscribing in learners the power of the generality and abstraction connected to formalization. Furthermore, ICT tools are current artifacts "which expand the language of mathematics, and allow learners wider scope for theoretical thinking and modelling in practice" (p. 566). These tools would lead to an enhanced form of quantitative abstract and general knowledge and being. For example, the following enunciation shows how deductive and abstract reasoning are achieved in geometry, in the move between everyday and informal knowledge to certain and secure formalized deductions and abstractions:

> research showing how novel activities aimed at generating surprise and uncertainty can strengthen students' need for deductive proof [...]; how 12-year-old students can move from everyday to mathematical explanations through [Dynamic Geometry Environments] (DGE) interactions [...]; and, how DGEs can help 14–15-year-old students connect their informal geometric explanations with logical, deductive arguments as long as the tasks used are undertaken with teacher support, including a teacher introduction to writing proofs. (p. 572)

This move is clearly favored by the operating facilities of current ICTs:

> dragging fosters students' access to the world of Geometric theory [...] students working with quadrilaterals, with the task of constructing a quadrilateral and modifying it into a special case with dragging [...] At the end of the unit, when asked to classify quadrilaterals into a family tree, the students were also able to answer questions of the form "why is one quadrilateral a special case of another?" (p. 577)

The moves between observation and theorization have found an effective shortcut:

> Students drag objects observing the figure in search for regularities and invariants (*e.g.,* wandering dragging): once they have found one and they express it through a conjecture, they shift from the spatio-graphical field to the theoretical field. And vice versa, they shift backward if they drag objects to check a conjecture already discovered (*e.g.,* guided dragging). (p. 580)

The act of dragging connects mind and body and trains the learner to do abstraction "with the fingers". This operation of ICT in pedagogical practices inscribes, through the body of the learner, ways of reasoning that format both mind and body to conceive of abstraction as a natural act. In short, "[g]enerality lies at the heart of mathematics" and hence "a lesson without the opportunity for learners to express a generality is not in fact a mathematics lesson" (p. 605).

In terms of subjectivity, success in school mathematics means to be able to effectively learn to be and operate with transcendental and universal categories that result from abstraction and formalization, such as space as geometrically defined, or the human as a representative of a rational species. The assemblage learner–ICT tools constitutes a "historically specific instance of a merging of an educational discourse on the cognitive development of the child with a modern faith in technology" (Shutkin, 1998, p. 220). As pointed out by Shutkin (1998), the current manifestations of the merging of child and technology for the purposes of learning—in our case mathematics—are examples of the reification of an important Modern idea: the human experience of technological progress goes hand in hand with the "foundationalist emphasis on the Cartesian cogito and its unified, rational subject" (p. 220).

Mathematics education inserts children in the great Modern narrative of knowledge for problem solving. Mathematics for problem solving makes it possible for children to see themselves as agents who can bring about change in the world and so contribute to the betterment and progress of society. The following sentences from the Handbook illustrate such reasoning:

> [S]chool must always be directed to real, problematic situations. (p. 555)

> [M]athematics itself is the technology for solving the problem. (p. 554)

> We have argued that mathematical modelling should ideally be conceived as adding "theoretical thinking" to real, practical problem-solving activity, and that this should have developmental consequences for students. (p. 565)

Since school and the "real world" are connected in the school intention of addressing problematic situations, children are conducted to identify and focus on them. Mathematics is given a privileged position for problem solving. Mathematics education makes children who are able to deploy "theoretical thinking" in "activities". In this way, it leads children to become high-level problem-solvers. Schooling in general and school mathematics in particular secures such a possibility for children. When ICT is also part of the assemblage of mathematics education, the learner can become an even more expert problem solver, since it becomes possible to bring "reality into school" and "mathematics to the world":

> using the Internet would allow the children to locate 'real-world' data, and perhaps promote a greater understanding of instances in which one encounters such data, thereby fostering an appreciation for the use of mathematics in the real world. (p. 699)

Furthermore, new technologies bring the self one step further. The homeless mind is not only a way of understanding the self as universal and unbounded to any locality. Current ICT tools break the limitations of space that launch the individual completely into the apparent universality of the virtual:

> Online mathematics courses have created a new form of "classroom," in which no physical space exists as the classroom. The new classroom is a combination of the place where each student-computer is a virtual environment where messages, videos, drawings are posted synchronously or asynchronously. In this sense, the classroom is in the Internet. (p. 692)

The desirable neoliberal child of ICT research

So far, our analysis has shown how in the Handbook text there are statements circulating about the desired Modern child. The question now is: what do the enunciations state about the neoliberal desired subject?

According to Lemke (2002), neo-liberalism is not "just an ideological rhetoric or [...] a political-economic reality", but rather a political rationality that renders "the social domain economic and [links] a reduction in (welfare) state services and security systems to the increasing call for 'personal responsibility' and 'self-care'" (p. 203). In order to govern in such a direction, neo-liberalism sets in operation new technologies of the self: each subject must learn to take responsibility and be in charge of its own life, learning, work and success. Each of us must become an entrepreneur who is responsible and accountable for his/her own destiny. As Foucault (2004) wrote: "This means that what is sought is […] a society subject to the dynamic of competition. Not a supermarket society, but an enterprise society" (p. 147).

Pedagogical strategies intended to make learners aware and responsible for their own learning govern children to become "life-long learners". In this way, the subject learns how to learn so that he/she becomes the agent of his/her own human capital (Saraiva & Veiga-Neto, 2009, p. 199). In mathematics classrooms, ICT tools favor such a process. The change in authority positions the student as the one who can and should steer his/her learning:

> With powerful tools in students' hands, the source of authority can shift toward the students themselves and teachers and students can engage in a newly defined relationship that includes not only the teacher, the tasks, and the students but also the technology. (p. 601)

Pedagogical practices fabricate the desired, self-regulated and active learner:

> Teachers recognized that when using [Computer Algebra Systems] they changed the didactic contract, moving from a general class teaching style to greater use of student investigation and discussion. (p. 633)

> Students learn math best if they are actively involved in discussing math. Explaining their thinking to each other, making their ideas visible, expressing math concepts, teaching peers and contributing proposals are important ways for students to develop deep understanding and real expertise. There are few opportunities for such student-initiated activities in most teacher-led classrooms. (p. 698)

Such students can even monitor and evaluate their own performance and those of their peers as well:

> In order to observe the work in progress with technology in a classroom, she [the teacher-researcher] developed a series of instruments for her own assessment and for students' self-assessment and co-assessment. (pp. 763-764)

> Additionally teachers reported many instances where students changed their opinions and moderated their responses when they saw other students' work: this provided additional opportunities for peer-assessment and self-assessment. (p. 746)

> other studies which found more opportunities for students to peer-assess other work and self-assess their own. (p. 746)

An important aspect of the governing of the self through ICT in mathematics education is evidenced here: working with peers can be used as a tactic to regulate students' learning and assessment. Teachers can engineer and improve this tactic to the extent that it is possible for students to "create their own equations" or, in other words, to be in charge of their own knowledge generation and, eventually, their own mathematical learning:

> [A group of researchers] studied the nature of student learning in a classroom setting where students had ongoing access to the Internet while in a mathematics class and access to an online discussion board between classes using Idea Construction Zone. While exploring the graphs that were generated for missing number equations like __ + __ = 10 and __ + __ = 7, they wondered if they could create their own equations that would make the graphs point in a different direction or make the graphs curve. (p. 707)

Technology is an important facilitator not only for moving the responsibility of learning from the teacher to the student, and for teaching the student to self-regulate his/her learning. It is also important for pursuing new learning even in times and space outside institutionally regulated learning spaces. This characteristic of technology is connected to the possibility of becoming entrepreneurial in any place, at any time; there are no limitations to the potential of the auto-regulated human being:

> Mathematics teaching is not limited to formal classroom settings. The Internet has become a vast resource of information. For example, a student can search on YouTube for "factoring" and find numerous videos that "teach" mathematics content related to this topic. (p. 692)

The students' conduct is steered by this logic to conduct their own conduct; in other words, to manage themselves according to this logic. With ICT in mathematics, the individual student becomes an entrepreneur of him/herself, which allows a permanent reconfiguration of him/herself in order to be competitive. This is important because, according to the Handbook text, there is a need to educate more mathematicians, scientists and engineers to strengthen societies. Mathematics education seeks:

> helping students aiming to be scientists and engineers, while at the same time supporting future teachers of mathematics and research mathematicians. (p. 535)

Such a hope, however, would be futile if it only addressed individuals. Many other technologies simultaneously operate on populations. International comparative tests, for example, set in place bio-political technologies that compare, classify and establish hierarchies among individuals, groups, countries and regions in an international order (Kanes *et al.,* 2014). Policy documents and their related technologies also govern populations and individuals to become desired mathematically competent citizens (Llewellyn, 2012). The conduct of students' conduct through pedagogical technologies is one of the sites of the wide network of technologies within which Modern, neoliberal subjectivities are fabricated.

So what is the matter?

Our analysis has shown that mathematics education research on the use of ICT for teaching and learning is an important part of the calculations of power. Through devising and deploying appropriate pedagogical technologies, it contributes to the government of school subjects to become the desired rational, Modern, self-regulated, neoliberal beings, who are to run current societies adequately. This outcome is highly desirable, according to not only research, but also public debates, educational policies, and international initiatives in education. So, what is the matter? One may ask: what does this type of analysis offer to mathematics education (research)?

We intended to problematize the now taken-for-granted, simple truth that mathematics education is empowering to individuals and society and, therefore, is desirable. Our questioning does not lead us to say that it is not. Rather, we raise the question of how desirable the *direction* in which mathematics education (research) currently conducts the becoming of school children might be. Mathematics education (research) is part of the processes of subjectivation in society, a subjectivation that governs school subjects to become *one privileged type* of being. This type of being is, on the one hand, a being that productively engages with the world, but it is also one of the many possible types of self that children can become. Within this type of self, many small nuances of an individual's personal variety are possible. However, our point is that the rational Modern, self-regulated, entrepreneurial, competitive, neoliberal, subject type is made possible, and, at the same time, differences in individual projects of subjectivation are rendered more difficult.

The questioning that emerges is precisely the tension arising when each individual—teacher, child, parent and even researcher—is confronted with the classifications and distinctions that this cultural thesis about the desired subject for society sets in operation. Any formulation of a desired subject brings with it mechanisms to select and classify those whose forms of life and being do not assimilate to the desired one. This is what Popkewitz (2008a) calls *abjection*, or the simultaneous process of inclusion/exclusion that operates when the expression of the "desired" establishes the criteria for inclusion and, at the same time and often implicitly, defines the hope for those who do not satisfy all the requisites it establishes. This means that any form of mathematics education, even the most aware and well-intended inclusive pedagogy, is always generating in/exclusion. Not being aware of how research is operating this constant classification of children is a severe blind spot to the good intentions of mathematics education with ICT as a means of empowerment for learners. The in/exclusion of children in relation to their mathematical capacity with ICT becomes a serious challenge to society. On the one hand, those who do not succeed are positioned as excluded and "losers" in the competition for employability and well-being. On the other hand, the compliant may also risk becoming the paradigmatic type of *cyber-capitalist* (Žižek, 2001) for whom the world offers infinite possibilities.

Foucault invites us to seriously consider what effect of power we researchers are producing in children and learners when, in the name of a desired future, we contribute to offering one dominant, master narrative of who the desired child in society is. To think our own thinking enhances the possibility of exercising counter-conduct movements, "in the sense of struggle[s] against the processes implemented for conducting others" (Foucault, 2007, p. 201). Hacking (2004) emphasizes that it is important to avoid a deterministic perspective, never forgetting that subjectivation processes happen in a space of freedom. It is from this freedom that lines of flight (Deleuze, 1995) can emerge. There is always the possibility of imagining and doing what is not yet considered to be possible. A critique that opens up such an imagining is also a relevant contribution of research.

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